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**DISCLOSURE OF HYDRAULIC FRACTURING  
FLUID CHEMICAL ADDITIVES: ANALYSIS OF  
REGULATIONS**

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**ABSTRACT**

Hydraulic fracturing is used to extract natural gas from shale formations. The process involves injecting into the ground fracturing fluids that contain thousands of gallons of chemical additives. Companies are not mandated by federal regulations to disclose the identities or quantities of chemicals used during hydraulic fracturing operations on private or public lands. States have begun to regulate hydraulic fracturing fluids by mandating chemical disclosure. These laws have shortcomings including nondisclosure of proprietary or “trade secret” mixtures, insufficient penalties for reporting inaccurate or incomplete information, and timelines that allow for after-the-fact reporting. These limitations leave lawmakers, regulators, public safety officers, and the public uninformed and ill-prepared to anticipate and respond to possible environmental and human health hazards associated with hydraulic fracturing fluids. We explore hydraulic fracturing exemptions from federal regulations, as well as current and future efforts to mandate chemical disclosure at the federal and state level.

**Keywords:** groundwater, Safe Drinking Water Act, contamination, legislation, fracking

Hydraulic fracturing, also known as fracking, is an increasingly widespread practice used to extract natural gas and oil from shale formations deep below the surface of the earth. Optimization of recovery technologies and lucrative natural gas prices led to a 48 percent increase in U.S. shale gas production from 2006 to 2010 with an estimated 35,000 wells drilled annually [1, 2]. Hydraulic fracturing involves drilling a vertical well approximately 5,000 to 9,000 feet into a shale formation [3]. Horizontal drilling, when appropriate, stems perpendicularly from the base of the vertical well and may extend outwards up to 10,000 feet [4]. Wells are drilled and lined by a steel pipe and cemented into place. After placement, electric currents are sent to a perforating gun located near the base of the well, where a charge shoots small holes through the steel and cement into the shale [3]. This allows the highly pressurized fluid-and-proppant mixture injected into the well to escape the well and create cracks and fractures in the surrounding shale layers [5]. Proppants are size-graded, rounded and nearly spherical white sand, ceramic, or man-made particles which are suspended in pressurized fluid [6]. The resultant fractures allow gas trapped within the shale to escape, along with some fracturing fluid and naturally occurring mineral deposits, and flow back up the well to the surface for capture [3].

### **FRACTURING FLUIDS AND ENVIRONMENTAL HEALTH**

Hydraulic fracturing is controversial. Proponents argue that fracking creates a novel source of cheap, domestic energy and may replace some “dirty” energy sources like coal-fired power plants [5]. They claim that using natural gas as a “clean” energy source will make it easier to meet federal air and water quality standards [7] while also reducing our dependence on foreign oil [4]. The website of Halliburton, one of the major corporate proponents of fracking, states: “fracture stimulation is a safe and environmentally sound practice based on the industry’s decades-long track record, as well as the conclusions of government and industry studies and surveys” [8]. In 2009, industry estimated undeveloped but recoverable shale gas reserves in the lower 48 states amounting to 24 billion barrels: enough to heat U.S. homes for 30 years [9, 10].

#### **Use of Fracturing Fluids**

Opponents of hydraulic fracturing cite concerns related to the environment, human health, and questions about the reality of promised long-term economic benefits in areas that are heavily drilled. The primary threat and controversy surrounding hydraulic fracturing, as it pertains to human health and groundwater contamination, is the use of fracturing fluids. Current estimates place the volume of fracturing fluid pumped into each well between 2 million and 4 million gallons, with the major components being water (90%),

sand or proppants (8-9.5%), and chemicals (0.5-2%) [11]. Chemicals are added to fracturing fluids to increase well productivity by creating fractures in the rock (mostly shale) formation and holding the fractures open for the release of natural gas. Fracturing fluid additives include proppants (particles that keep fractures open), acids, gelling agents (which thicken the fracturing fluid), gel breakers (which allow fracturing fluid and gas to flow easily back to surface), bactericides, biocides, clay stabilizers, corrosion inhibitors, crosslinkers (which help maintain viscosity of fracturing fluid), friction reducers, iron controls, scale inhibitors, and surfactants. The composition of the fluid is determined based on characteristics of the well (e.g., geology of area) and production objectives. Some of the identified chemicals have known human health effects. For example, the surfactant benzene is classified by the U.S. EPA as a known human carcinogen (Group A), and xylene is a central nervous system depressant [12, 13]. Since companies invest time and resources into perfecting their fluid technologies, industry views chemical recipes as proprietary information that should be protected as trade secrets; thus many of the chemicals used remain unknown [5, 14].

The use of chemicals in the natural gas extraction process is not limited to the injection of fracking fluids. During the initial process of drilling the vertical well, chemicals are added to “drilling muds” to reduce friction, ease the drilling process, and shorten drilling time [14]. In addition to concerns regarding contamination of water during the drilling and fracturing process, there are concerns about groundwater contamination from the salts, chemicals, and naturally occurring radioactive material present in flowback, which is usually temporarily pumped into wastewater ponds and then moved off-site, where it is re-injected back into the ground or transferred to wastewater treatment facilities for treatment and disposal. The practice of treating flowback and “produced water” at publicly owned treatment works (POTWs) has largely ended; particularly in Pennsylvania, where less than 1 percent of fracking wastewater is treated in this manner after the state’s Department of Environmental Protection (PaDEP) asked POTWs to voluntarily stop accepting fracking wastewater [15]. Now, the majority of flowback or “produced water” that is not disposed of in injection wells is treated at centralized waste treatment (CWT) facilities that are designed to treat industrial wastewater, and which may then discharge into sewers or surface water bodies. However, a report by the Natural Resources Defense Council (NRDC) found that wastewater discharged from these CWT facilities into surface water bodies still contained high levels of salts, bromides, and other pollutants [15].

Between 2009 and 2011, the EPA investigated potential groundwater contamination due to fracking in Pavilion, WY, and released its draft report in December 2011 [16]. EPA detected high concentrations of benzene, xylenes, and other gasoline and diesel range organics (types of petroleum hydrocarbon compounds), indicating a source of shallow groundwater contamination [16].

This EPA report is one of the few investigations of possible environmental contamination by hydraulic fracturing fluid injection. A single EPA report from 2004 found minimal risk to underground sources of water due to hydraulic fracturing; however, this study was conducted in an area where coalbeds were being fractured, and not shalebeds where the vast majority of fracturing occurs today [17]. No EPA reports to date have been released regarding the risks to groundwater and air associated with hydraulic fracturing in shalebeds. However, in 2011, Osborn and colleagues at Duke University published a study that showed increased concentrations of methane, ethane, and propane in private drinking-water wells directly attributable to the gas-well drilling in the Marcellus shale formation of Pennsylvania and New York [18]. The same research group did not find evidence of increased salinity or contamination from fracking fluids in a sample of private drinking-water wells [19]. However, these two studies and others acknowledge that hydraulic fracturing increases the permeability of shalebeds, creating new flow paths and enhancing natural flow paths for gas leakage into aquifers; these same pathways create a possible, although unlikely, contamination pathway for fracturing fluids [18-20]. The creation of additional fractures in the shalebeds and the drilling of wastewater disposal injection wells also change the hydrostatic pressure of the shale formation, possibly speeding up the normally extremely slow vertical flow of native and injected fluids closer to aquifers and the surface [20].

### **Voluntary Chemical Disclosure**

With the exception of state-specific laws, disclosure of the chemicals present in fracturing fluid is primarily based on self-regulation: that is, voluntary reporting by the natural gas companies. Starting in January 2011, the Groundwater Protection Council and the Interstate Oil and Gas Compact joined forces to create the website [FracFocus.org](http://FracFocus.org). Natural gas companies can provide well-specific information including the chemical composition of the fracturing fluid used at that particular well [21]. The chemical information may include Chemical Abstract Service (CAS) numbers, the purpose of an additive (e.g., proppant, biocide, gelling agent), and the maximum volume of the additive in hydraulic fracturing fluid [21]. The reporting of hydraulic fracturing chemicals is completely voluntary, and thus the accuracy and completeness of the information reported is unknown. The website does provide guidance stating that any chemical that has a Material Safety Data Sheet (MSDS) and is deemed nonproprietary should be reported [21]. However, chemicals are often reported as classes of chemicals (e.g., carbohydrate polymer, aliphatic alcohol), so that the exact identity of the chemical is unknown. While voluntary reporting is a first step toward increasing disclosure and public knowledge—and industry and some state governments view it as sufficient—the website does not have any government oversight nor does it provide complete information for lawmakers,

regulators, or communities regarding the specific chemicals that are being injected during hydraulic fracturing.

Recently, The Endocrine Disruption Exchange (TEDX)<sup>1</sup> conducted a study to determine chemical mixtures present in fracturing fluids [14]. TEDX created a list of 944 products currently used in natural gas operations as reported by a variety of sources including the U.S. Bureau of Land Management, the U.S. Forest Service, state government departments, and the natural gas industry. Among those products, 632 different chemicals were identified (e.g., methanol, ethylene glycol) [14]. More than 75 percent of the chemicals identified in the TEDX report are known to affect the skin, respiratory system, and/or the gastrointestinal system. Further, approximately 50 percent of the chemicals are known to have effects on the nervous system, immune system, and/or cardiovascular/circulatory system [14].

The chemical additives are undeniably a small fraction of the fluid composition. However, they consist of up to 2 percent of approximately 2 million gallons of fluid used in each operation; which results in nearly 40,000 gallons of undisclosed chemicals used at each well [11]. TEDX was able to identify many chemicals commonly used in fracturing fluid; however, it reports that for 43 percent of the products it investigated, only 1 percent of the total chemical composition of the product was identified [14]. This demonstrates that the precise chemical makeup of most fracturing fluids remains largely unknown. Lawmakers and the public lack information regarding the chemical mixtures used in fracturing fluid because companies are largely not required to release this information to regulators or the public. There is no federal regulation that mandates chemical disclosure, and state regulations exist but are varied. Lack of full chemical disclosure prevents us from understanding possible health and environmental effects associated with hydraulic fracturing and injection of fracturing fluids, as well as preventing proper monitoring of chemical contamination as a result of hydraulic fracturing operations.

### **HYDRAULIC FRACTURING EXEMPTIONS IN FEDERAL REGULATIONS**

Currently there are no federal regulations requiring natural gas companies to disclose information about chemicals used in hydraulic fracturing fluids. As a technology used by the natural gas industry, hydraulic fracturing is often considered a protected practice in laws from which the oil and gas exploration industry as a whole is exempt from regulation, including the Emergency

<sup>1</sup> TEDX ([www.endocrinedisruption.com](http://www.endocrinedisruption.com)) is a nonprofit organization whose mission is to prevent harmful exposures to endocrine-disrupting chemicals by seeking out, selecting, organizing, reviewing, and interpreting scientific research.

Planning and Community Right-to-Know Act of 1986 (EPCRA) [22]. Hydraulic fracturing as an injection process is specifically exempt from the Safe Drinking Water Act (SDWA) [23, 24].

### **Emergency Planning and Community Right-to-Know Act**

Hydraulic fracturing and reporting of the chemicals used in fracturing fluid is exempt from EPCRA [24]. Section 313 of EPCRA created the Toxic Release Inventory (TRI), which requires companies that manufacture and/or use toxic chemicals to report information on chemicals, including identities and quantities that are stored, released, transferred, or “otherwise used” [25, 26]. The reporting requirements for toxic chemical releases include any intentional or unintentional discharge of toxic chemicals into the air, water, and/or soil [25]. Except for chemicals claimed as trade secrets, the information reported to TRI is deemed public knowledge, so that communities remain informed about possible chemical exposures [26]. However, the North American Industry Classification System (NAICS) code for Oil and Gas Extraction is not listed under Section 313 of EPCRA, exempting this industry from reporting information on the release of toxic chemicals [26]. Consequently, quantities of chemicals used in hydraulic fracturing fluid are not subject to TRI reporting guidelines.

### **Safe Drinking Water Act**

Historically, the EPA did not regulate hydraulic fracturing under the Underground Injection Control (UIC) Program of the SDWA because the combined processes (well-drilling, injection of hydraulic fracturing fluids, and natural gas extraction) were considered primarily “extraction” processes rather than “injection” processes [17]. The UIC Program is responsible for regulating the construction, operation, permitting, and closure of injection wells that place fluids underground for storage or disposal [27].

However, a 1997 decision by the 11th Circuit Court of Appeals in a lawsuit brought by the Legal Environmental Assistance Foundation (LEAF) against EPA required the agency to regulate hydraulic fracturing in Alabama as a Class II injection well (injection related to the production of oil and gas) under the UIC Program of the SDWA [28].

LEAF originally petitioned the EPA on behalf of the McMillian family, who claimed that nearby fracking had contaminated their well water [29]. The petition requested that the EPA withdraw Alabama’s primary enforcement responsibility (known as primacy) for the state’s UIC program until the state included regulations for the injection of hydraulic fracturing fluids as part of the program plan [29]. If included under this regulation, injection of fracturing fluid would be subject to a permitting, reporting, and monitoring process [26]. The EPA asserted that the UIC Program under the SDWA does not specifically require

regulation of hydraulic fracturing and maintained that it had no legal requirement to regulate hydraulic fracturing as an injection process [30]. The 11th Circuit Court of Appeals disagreed with the EPA. Following the court's decision, the EPA was required to conduct a study to assess the risk posed to human health by the process of hydraulic fracturing.

While EPA's study was ongoing, in 2003, the agency entered into Memorandum of Agreement (MOA) with three companies which are together responsible for 95 percent of the hydraulic fracturing projects in the United States. As part of the MOA, these companies would not use diesel as part of the fracturing fluid mixture when they are removing natural gas from areas near underground drinking water sources. However, this MOA is not enforceable, and there is no penalty for a company should it wish to terminate the agreement [31].

EPA's court-mandated report, issued in 2004, determined that no further study into the health effects of hydraulic fracturing was necessary. Critics have questioned the legitimacy of this study because it did not involve any data collection, instead depending on existing literature and interviews with industry representatives and state and local government officials. In addition, the study considered effects on drinking water only from drilling in coal beds, but fracking takes place in additional types of substrates [32].

Regardless of the alleged flaws in the EPA report, in August 2005 Congress passed the Energy Policy Act exempting fracking from regulation under the 1974 Safe Drinking Water Act [17]. Specifically, the Energy Policy Act included in Section 322 an amendment to Section 1421(d)(1) of the SDWA exempting hydraulic fracturing as an underground injection process (42 USC 15801 § 322). The amendment states that underground injection "excludes – (i) the underground injection of natural gas for purposes of storage; and (ii) the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities" [23].

## **FAILED ATTEMPTS AT FEDERAL REGULATION**

Two acts introduced in the last five years, and one proposed rule by the Obama Administration [33], attempted to amend federal exemptions of hydraulic fracturing and/or introduce provisions mandating the disclosure of the chemical composition of fracturing fluid. All three attempts to regulate chemicals in fracturing fluid at the federal level failed. A third act has proposed to specifically designate this as a responsibility of states.

### **The American Power Act**

In 2010, Senators John Kerry (D-MA) and Joseph Lieberman (I-CT) introduced the American Power Act, which included a section amending Section 324

of the Emergency Planning and Community Right-to-Know Act of 1986 [34]. As mentioned previously, as a practice of the oil and gas extraction industry, hydraulic fracturing is not included in the list of activities/industries required to report toxic chemical releases under EPCRA. Section 4131, Notice of Hydraulic Fracturing Operations, of the proposed American Power Act stipulated that “a hydraulic fracturing service company shall disclose all chemical constituents used in a hydraulic fracturing operation to the public” [35]. The bill would have required information to be distributed to the public via the internet, for the benefit of both private citizens and state and local authorities who are often unaware of the fracturing chemicals being used in their regions [35]. The Act was reportedly opposed for reasons unrelated to the hydraulic fracturing amendment clause and never made it out of committee [34].

### **The Fracturing Responsibility and Awareness Act**

The Fracturing Responsibility and Awareness (FRAC) Act entered House and Senate committees in both the 111th and 112th Congressional Sessions with the sole purpose of regulating hydraulic fracturing at a federal level [36]. The FRAC Act had two major purposes: (1) to amend Section 1421(d)(1) of the SDWA by removing the clause that exempts hydraulic fracturing from regulation under the UIC program; and (2) to mandate the disclosure of fracturing fluid chemical composition by adding regulations to Section 1421(b) of the SDWA, which outlines requirements for State UIC programs [37].

The chemical disclosure requirements in the FRAC Act had four specific objectives. First, operators of a well site must disclose to a designated federal or state regulator a list of chemicals intended for use before the fracturing fluid is injected [36]. When injection and extraction operations are complete, the operator must disclose the list of chemicals that were present in the fracturing fluid that was actually used [36]. Specifically, for every chemical being used (intended and actual), companies must disclose names (including CAS numbers), safety information (MSDS), and specific volumes of each chemical used. Second, the disclosure clause stipulated that information on nonproprietary chemicals be released to the public [36]. Third, if a spill occurs or an emergency situation arises, well operators must disclose the specific identity of all proprietary chemicals so that regulators and emergency personnel can properly address the situation [36]. Finally, the bill allows for proprietary information to be excluded from public disclosure in emergency and non-emergency situations [36]. Only information on nonproprietary chemicals will be released into public domain.

Supporters of the FRAC Act emphasized that the proposed amendment to the SDWA made certain that hydraulic fracturing would be regulated under “a consistent set of federally enforceable regulatory requirements” [38]. Senator Casey (D-PA) released a statement saying, “Disclosure will ensure that if drinking water supplies, surface waters, or human health are compromised,

the public and first responders will know how to respond properly. I view disclosure as a simple matter of citizens having a right to know about all risks in their community” [38].

Opponents of the act included state lawmakers, industry representatives, and even some environmental groups. State lawmakers made arguments against the FRAC Act, asserting that states where hydraulic fracturing is common practice already effectively regulate operators [39]. Furthermore, they argued that each state is best equipped to create laws that address the state’s geologic subtleties, which may necessitate differing operating practices [40]. Despite a specific clause protecting proprietary chemical identity from public release, industry expressed concerns over the disclosure of proprietary chemicals to federal regulators [39]. They feared protection of the information would not be sufficient and release of trade secret information would damage their competitive edge in the natural gas market. Some environmental groups were also critical of the FRAC Act, saying it did not go far enough in regulating hydraulic fracturing. Environmental groups disagreed with the continued protection of proprietary chemical information and cited shortcomings of the information being released about nonproprietary chemicals [36]. Their main concern is the lack of information provided by the MSDS, which often does not include health effects from environmental exposure to chemicals [36]. In addition, MSDS information exists for only a limited number of chemicals; only chemicals deemed hazardous by the Occupational Safety and Health Administration (OSHA) will have an MSDS [26, 41]. The bill was not passed into law; indeed, it did not make it out of committee during either Congressional session.

### **Fracturing Regulations are Effective in State Hands Act**

On March 28, 2012, Senator Inhofe (R-OK) and Senator Murkowski (R-AK) introduced the Fracturing Regulations are Effective in State Hands (FRESH) Act [42]. This act is designed to guarantee that states, not the federal government, have exclusive authority to regulate hydraulic fracturing activities within state boundaries [42]. Justification of sole state regulatory authority is based on a “lack of evidence” that hydraulic fracturing in one state presents a contamination risk to groundwater in another state [42].

## **FRACTURING REGULATIONS AT THE STATE LEVEL**

Arkansas, Colorado, Montana, Ohio, Oklahoma, Pennsylvania, Texas, and Wyoming have enacted fracturing disclosure laws [43, 44]. As of this writing, Ohio’s disclosure law is the most recent to pass, effective August 1, 2012, and reflects some lessons learned from other states [44]. We draw on the examples

of Texas and Pennsylvania, periodically referring to Ohio, to illustrate the issues of contention among environmental health professionals and advocates, regulators, and industry.

### **State of Texas**

Texas is one of the first states to enact a chemical disclosure regulation specific to fracking. The “Hydraulic Fracturing Chemical Disclosure” rules adopted in Texas have become the blueprint for regulation in other states. Many of the technologies responsible for increasing natural gas yields were borrowed from the Texas offshore oil and gas industry. Hence, Barnett Shale natural gas production increased 3000 percent from 1998 to 2007, making Texas the unofficial leader in energy resource recovery through hydraulic fracturing [4]. Texas has fought aggressively to maintain state control over regulations, with some Texans arguing that potential impacts of hydraulic fracturing such as “groundwater contamination, wastewater disposal, impacts to local character, and seismic impacts are essentially local in nature . . . and do not cross state boundaries,” and thus should be regulated at the state instead of at the federal level [45].

The Rail Road Commission (RRC) is the primary agency that regulates Texas’ oil and gas industry. Regulations prior to 2012 primarily identified and established a clear definition of well operators (i.e., owners or managers), confirming the financial security of a well operator, and establishing procedures for public notice of new applications for injection well permits received on or after September 1, 2005 [46]. Areas surrounding aquifers, usually protected from drilling activities, may be used for underground injection wells if the well operator applies for an aquifer exemption [46].

In response to public pressure and possibly as a mechanism of preempting federal oversight, the RRC adopted new rules on December 13, 2011, requiring the disclosure of the intended, nonproprietary chemicals used in hydraulic fracturing fluids [47]. These rules apply to treatments occurring on wells that have been issued an initial drilling permit on or after February 1, 2012, but do not place disclosure requirements on wells with prior permits [46]. This regulation requires the operator of the well to provide general information about the well’s location and dates of drilling activities, volume of water used, and each intended additive—its CAS number, intended use, and its maximum concentration by mass [46]. There is no requirement to report chemical components of hydraulic fracturing fluid before the fracturing activities begin. Instead, no later than 15 days *after* completion of a hydraulic fracturing treatment, the operator is required to file the chemical disclosure report with the RRC, and this information will be uploaded to the FracFocus website and henceforth be considered public information [46]. The RRC is responsible for enforcement, and violations may result in “monetary penalty and/or lead to the revocation of a well’s certificate of compliance” [47].

The chemical disclosure requirements in Texas, as in many of the other states with disclosure rules, have significant loopholes, which provide allowances for incomplete disclosure of the chemicals and quantities used, as well as the disclosure of inaccurate information. First, the rule requires reporting of only “actual or the maximum concentration of each chemical ingredient . . . in percent by mass” [48], instead of the total amount of the chemical used at the site. Second, chemicals that are “unintentionally added” or “occur incidentally” are exempt from disclosure [48]. Another caveat of the disclosure law is that suppliers, service companies, and operators are not held responsible for the reporting of inaccurate information to the RRC [48]. Chemicals entitled to trade secret protection can be entirely exempt from public disclosure, unless disclosure is considered necessary during an emergency situation [47]. In Texas, certain commercial or financial information can be exempted from public disclosure laws if, “based on specific factual evidence, disclosure would cause substantial competitive harm” [49]. The factors that determine if information qualifies for trade secret protection are: the extent to which the information is known by employees within or people outside of the company; the measures taken or amount of money expended by the company in developing and guarding the secrecy of the information; the value of the information to the company; and the ease with which the information could be acquired or duplicated by others [50]. If an emergency situation arises, the presence of additives protected by trade secret must be disclosed to emergency responders or health professionals to allow for proper cleanup and/or medical treatment for exposed individuals [48]. In the case of Texas, first responders must sign a statement of confidentiality, and are allowed to discuss chemical identities only with other first responders or accredited laboratories; they are not permitted to disclose chemical identities to the person(s) receiving medical care [48]. In contrast, Ohio’s recently passed law provides that “Doctors may share even proprietary chemical information with the patient and other medical professionals directly involved in treating a patient” [51]. While these state regulations are intended to establish transparency, they each fall short of full chemical disclosure and provide effective immunity to companies reporting inaccurate data.

### **Commonwealth of Pennsylvania**

It has been known since the 1930s that natural gas existed in the Marcellus Shale formation in Pennsylvania; however, conventional vertical drilling was not successful because the gas occurs in “pockets,” and therefore flows could not be sustained [2, 52]. In 2003, Range Resources–Appalachia began drilling wells, modifying the horizontal drilling techniques utilized in the Barnett Shale; by 2005, Marcellus gas was flowing [52]. Some assessments estimate more than \$500 billion in recoverable natural gas exists in Pennsylvania alone,

bringing on a drilling frenzy and leading to the creation of more than 350,000 active and inactive gas wells in Pennsylvania [7].

In Pennsylvania the Public Utilities Commission and the PaDEP are responsible for policing oil and gas activities. In 2008, a state investigation found 18 methane-contaminated wells after drilling activities began in the Susquehanna County area [53]. PaDEP fined the drilling company \$120,000 and required potable water be brought in until the company installed gas mitigation devices at each residence [53]. In a 2009 incident, gas migrated into a residential water well and exploded, spewing fracturing fluid, brine, unknown chemicals, and gas into a forest about 90 miles outside of Pittsburgh [4]. These and other spill events have intensified public pressure on the pro-drilling Pennsylvania administration to require disclosure of the chemicals used in hydraulic fracturing fluids.

Pennsylvania General Assembly signed a new reform amendment into law on February 14, 2012, providing updates to the 1984 Oil and Gas Act [54]. The new act is designed to update environmental regulations, drilling fees, and local regulations for conventional and unconventional (i.e., hydraulic fracturing) oil and gas operations in the state. Within 60 days of commencement of drilling activities, well operators must complete a chemical disclosure form and post it to the industry-run registry [55]. The chemical disclosure form requirements are essentially identical to those of Texas; for example, they do not require disclosure prior to the start of fracking activities, they include exemptions from disclosure of proprietary information, and they do not hold operators, vendors, or service providers responsible for providing inaccurate data to the registry [55].

## **REGULATORY CHALLENGES AND FUTURE REGULATORY PROSPECTS**

### **Enforcement**

In some states, including Texas, companies have been slow to comply with the disclosure regulations [56, 57]. The NRDC found that state regulators were consistently accepting disclosure reports that were missing information required by Texas's hydraulic fracturing chemical disclosure rules [56]. Further, other investigations have found that almost half of new wells drilled in Texas go completely unreported and disclosure reports are not submitted to FracFocus [57]. These failures to comply indicate that some states are not providing adequate oversight.

In 22 states, the number of new oil and gas wells grew 45 percent between 2004 and 2009, leaving regulators scrambling to keep up. Complaints of understaffing within the responsible departments persist. Common jobs of state regulators include "policing" gas wells, oil wells, waste injection wells, disposal pits, compressor stations, and access roads. In addition, they are responsible for approving new permits, visiting new wells and old ones before they are sealed,

and responding to complaints of all kinds [58]. An example of the insufficiency of state staffing of regulatory agencies can be found in Texas. In 2009, Texas had 273,660 wells and 106 regulators charged with overseeing them. In 2007, the Texas state auditor issued a report on the RRC's enforcement record. The auditor found that between 2001 and 2006, about half of the state's wells had not been inspected. The report also found that 30 percent of all spills were inspected late or not at all. Despite the growing workload, the budget is getting smaller. Between 2005 and 2009 the commission's budget for monitoring and inspections decreased by 10 percent. Even when regulators conduct inspections, there are sometimes flaws in their work [58].

While regulation of chemical disclosure is occurring at the state level, the examples of Texas and Pennsylvania highlight shortcomings and loopholes that result in the provision to the public of inadequate information—or misinformation—regarding the chemical composition of hydraulic fracturing fluids. The above examples also point to a lack of compliance due to failed state oversight. Federal regulation and oversight may be necessary to ensure that sufficient and accurate information is being reported. We suggest that the federal government not preempt state regulation of fracking, but at a minimum require adequate chemical disclosure to federal, state, and local regulators, and to the public.

### **Future Prospects**

In the FY2010 Budget, the U.S. House of Representatives Appropriations Conference Committee included funds for a new EPA study on the effects on drinking water of hydraulic fracturing of shale formations [26]. EPA's first action was to request the chemical composition of drilling muds and fracturing fluids from nine of the largest natural gas and hydraulic fracturing companies [59]. The EPA recognized this as the fundamental first step in completing "a more thorough assessment of the potential impact of hydraulic fracturing," which underscores the importance of chemical disclosure [59]. The EPA study is underway and an initial progress report is expected in late 2012.

In March 2011, President Obama instructed the Secretary of Energy Advisory Board (SEAB) to create a subcommittee focused on exploring options for improving the safety of and public support for shale gas development [40]. From this charge, the Shale Gas Production Subcommittee completed two reports in which disclosure of fracturing fluid composition is a recommendation on the list "for immediate implementation" [40]. The Subcommittee recognized the work done by industry on the FracFocus.org website as a first step and believes that "disclosure should include all chemicals, not just those that appear on MSDS" [40]. The Subcommittee also envisions that disclosure of the chemical composition of fracturing fluid will appear on a well-by-well basis and that this information will be made publicly available via a website. While this call for complete disclosure is encouraging, the Subcommittee's implementation plan is

lacking. The Subcommittee recommends relying on the Department of Interior to design and implement a plan for requiring chemical identity disclosure of fracturing fluids on federal lands [40].

The Department of Interior Bureau of Land Management controls all federal and public lands and has historically allowed natural gas extraction, including the use of hydraulic fracturing on public lands. In May 2012 the Bureau of Land Management issued a proposed rule [33] that would have required industry to report fracturing fluid composition prior to drilling on public lands, but the Obama Administration reportedly backed off from this demand, agreeing to allow companies to reveal the contents of drilling fluids after the fact [61].

Efforts also continue to update federal regulations to include hydraulic fracturing under some of the major environmental laws. In August 2011, the environmental group Earthjustice petitioned the EPA on behalf of over 100 community and environmental groups across the country [62] calling for EPA to pursue regulation of hydraulic fracturing (including drilling muds and fracturing fluids) under Section 4 and Section 8 of the Toxic Substances Control Act (TSCA) (15 USC § 2620) in order to protect “public health and the environment from the serious risks posed by chemical substances and mixtures used in oil and gas exploration and production” [62]. The group requested that EPA pursue, under TSCA Section 4, a requirement for manufacturers and users of fracturing fluids to identify all chemicals used and to conduct toxicity testing on those chemicals [62]. The information gained from the disclosure of chemicals and toxicity testing would be used to evaluate impacts on human health and the environment. Under TSCA Section 4, the EPA has “authority to require testing of chemicals which may present a significant risk or which are produced in substantial quantities and result in substantial human or environmental exposure” [26]. Additionally, Earthjustice asked EPA to adopt a rule under TSCA Section 8(a) requiring manufacturers and users of fracturing fluids to maintain, update, and submit records to EPA regarding specific chemical identities, proposed categories of use, potential byproducts, and existing and/or new environmental and health effects data [62]. Under TSCA Section 8 the EPA can implement “recordkeeping and reporting requirements to ensure that the EPA administrator would continually have access to new information on chemical substances” [26].

In November 2011, the EPA Assistant Administrator Stephen Owens responded to the Earthjustice petition in two separate memos [63, 64]. First, the EPA denied the petition’s first request for adoption of a rule under TSCA Section 4 requiring toxicity testing for all chemicals used in fracturing fluid [63]. The EPA stated that the petition “did not set forth facts sufficient to support the required findings under TSCA Section 4(a)(1)(A) or 4(a)(1)(B) for issuance of a test rule” [63]. The EPA response memo suggests Earthjustice did not sufficiently identify a “risk trigger” (TSCA Section 4(a)(1)(A)) or an “exposure trigger” [26]. A *risk trigger* is defined under TSCA as a chemical that the EPA determines presents an “unreasonable risk of injury to human health or the environment”

[26]. An *exposure trigger* is defined under TSCA as a chemical that is “produced or released into the environment in substantial quantities” [26].

The burden for EPA of proving that a chemical (or a group of chemicals) is either a risk trigger or exposure trigger is very high. The catch-22 for both of these rules is that often data do not exist that would allow the EPA to conduct a risk determination for a chemical. While the EPA can require testing if it finds that insufficient data exist, often the agency must still prove “unreasonable risk” for the risk trigger and “substantial quantities” for the exposure trigger. In essence: no data, no risk; no risk, no data.

In the EPA’s second memo, it partially granted petitioners’ request for initiating a “rulemaking process” under TSCA Section 8(a) requiring some reporting on chemicals used in fracturing fluids [64]. As a first step, the EPA will convene a “stakeholder process” to determine an approach for reporting that will involve minimal cost and duplication of effort while maximizing information, transparency, and public understanding [64]. States, industry, and public interest groups will be allowed to participate in the dialogue [65].

While there is some movement toward regulating hydraulic fracturing, and mandating chemical disclosure appears to be high on the list of priorities for environmental and community groups as well as some federal legislators, the process of changing federal regulations is slow and will continue to be challenged by industry and some lawmakers.

## CONCLUSIONS

Advancements in natural gas recovery technologies and attractive prices have spurred a modern day “gas rush,” leading to a 48 percent increase in U.S. shale gas production from 2006 to 2010 [1]. Natural gas extraction using hydraulic fracturing does provide benefits, such as a domestic energy source that may be cleaner than coal. However, these benefits should not exempt the industry from federal environmental laws that are put in place to protect public health and the environment. Hydraulic fracturing activities come with a cost—incidents of leaking pipelines, wellhead explosions, lack of wastewater treatment, and toxic air emissions, which can lead to significant cleanup costs and environmental health impacts—so regulation is necessary [4]. To mitigate these environmental and human health costs, all hydraulic fracturing activities should be better regulated. The SEAB recommended regulations to reduce air emissions from hydraulic fracturing practices and also regulations to ensure water management and groundwater safety [40]. We view regulation of hydraulic fracturing fluid chemical disclosure as a first step towards other hydraulic fracturing regulations. To create an enforceable and protective regulatory program, lawmakers should first have knowledge of the chemicals used in these processes and then determine whether the chemicals require regulation to protect public health and safety and the environment.

Shortcomings of state regulations, their variable enforcement, and limitations of the current voluntary reporting mechanism lead us to recommend federal regulations requiring full disclosure of chemical additives in hydraulic fracturing fluids. A federal law that both lifts current federal exemptions for hydraulic fracturing and mandates complete disclosure of chemicals (including proprietary and nonproprietary chemicals, and MSDS and non-MSDS chemicals) is essential. Federal regulations are crucial for setting a baseline of disclosure requirements that all states are required to follow. The foundation for creating federal regulation is a strong scientific base and the consideration and protection of human dignity, equity, and distributional impacts that are not requirements for state regulations or voluntary guidance [66]. Without information on the chemicals of concern, our regulations cannot be informed by scientific information or other knowledge regarding health risks. Oversight at the federal level could ensure that a standard set of regulations will be applied to hydraulic fracturing operations across the country.

Lastly, federal oversight of hydraulic fracturing will standardize and streamline regulatory processes, which can lead to economic benefits. In fact, the U.S. Office of Management and Budget recently reported the estimated cost and benefits associated with federal regulations [66]. The report concluded that, over the course of a decade (FY2001-FY2010), major federal regulations provided an estimated \$132-\$655 billion in net positive benefits while costing taxpayers between \$44 billion and \$62 billion [66]. Federal regulations enforcing the EPA's Clean Water Act, SDWA, and Clean Air Act were among the regulations that produced the highest net benefits compared to costs [66].

The current status of disclosure prevents the public, lawmakers, and scientists from understanding possible health and environmental effects, and also prevents proper monitoring of chemical contamination as a result of hydraulic fracturing operations. We believe federal regulations are essential to ensure that air and water quality will not be compromised, minimum requirements for chemical disclosure will be standardized across all states, and responsible parties will be held accountable if the natural environment or public health is harmed.

#### **ACKNOWLEDGMENT**

The authors wish to thank Nora Doyle-Burr for her contributions.

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